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The New Creation: An Update on Animal Gene Engineering

There have been several new developments in genetic engineering that show how this new industry is applying biotechnology in agriculture and medicine. How valuable these new developments are—in terms of real progress in improving agricultural practices and human health—remains to be seen. The following examples clearly reveal that the "New Creation" and new world order of the biotechnology industry is far from any utopian dream of a world made perfect for humankind. One can read between the lines of the new patent applications, news releases and scientific reports concerning the latest feats of genetic engineering and glimpse into the future. The wonder-world of the New Creation is not quite here today, but it may be upon us sooner than we expect. A whole new generation of genetically engineered (so-called transgenic) animals is on the horizon. These will carry genes taken from humans and other species. In the world of trade and commerce, they will be regarded as "new" species—unique, patentable commodities of the new world order.

TRANSGENIC ANIMALS

Scientists in the U.S., Japan, Europe and Australia have created a number of transgenic animals—pigs, lambs, calves and fish—containing the genes of other species like the human and bovine growth hormone genes. Success rates of gene insertion are extremely low and the entire process is time consuming and costly. Much of the funding in this area of biotechnology comes from the public via government tax revenues.

Some researchers have recently opted to put extra growth-regulating genes of sheep origin into lambs rather than human genes because they felt that "transgenes composed entirely of sheep gene sequences would be more acceptable to lay persons, in particular consumers" (Murray and Rexroad, 1991). However, even though these lambs were leaner, they did not have increased feed efficiency. They were diabetic and had such severe health problems that they died before reaching puberty. "The cause of death has varied, but there are clear data that the over-expression of GH (growth hormone)

adversely affects liver, kidney and cardiac function" (Murray and Rexroad, 1991).

Merck & Co., the European-based pharmaceutical company, has applied for a patent in Europe on its super chicken, or Macro-Chicken (Holden, 1991). They have developed a line of broiler chickens that carry the growth gene of cows with the hopes of cornering the market with a highly feed-efficient, fast-growing bird.

It is likely that Merck's Macro-Chickens will have a variety of health problems too. But if the birds eat well and grow quickly, they will be ready for slaughter before severe health problems ever develop. But what of the breeding stock of transgenic chickens that will not be raised for slaughter? Will they suffer? Because such information is proprietary, corporations are not likely to reveal the limitations and risks of their new patentable creations. Trade secrets notwithstanding, the social and economic consequences—to farmers, to the practice and structure of agriculture and to consumers—of creating transgenic farm animals have been given scant attention.

Critics of the genetic engineering of farm animals question the use of public funds to make these animals produce more meat (even if it *is* lean) when the short- and long-term costs of such research are not considered and when a major problem of contemporary intensive animal agriculture is overproduction, meat and milk surpluses being a chronic problem. It is unlikely that the creation of transgenic farm animals will help feed the hungry world since meat production efficiency has built-in limitations and inevitable environmental costs (Durning and Brough, 1991; Fox, 1990).

Genetic engineering technology is being used in an attempt to alter sheep's and cows' milk so that it can be consumed by a large percent of the world population that is lactose-intolerant (Mercier, 1987). This may be a more fruitful approach to helping feed the hungry, since milk production is far more efficient, ecologically sound and cost-effective than meat production, with or without biotechnology.

Human genes responsible for the production of proteins in mothers' milk are being inserted into calf embryos with the hope of creating a new generation of cows that produce "humanized" milk (Phelps, 1989).

Australian government scientists are using genetic engineering to make sheep produce more wool by inserting genes into their developing embryos. The sheep's body chemistry is altered to convert sulfur-bearing compounds into methionine, an amino acid that increases wool growth (Ford, 1988). Australian scientists are also trying to genetically engineer a hormone that can be injected into sheep that will make them shed their fleece, thus cutting down costs of shearing. Tests to date have caused pregnant sheep to abort (Scherer, 1992; *New Scientist,* 1992). They also plan to genetically engineer sheep that secrete insect repellent from their hair follicles to ward off blowflies. Blowflies cost the sheep industry $85 million per year in losses. As a spinoff, the sheep will also have the world's first moth-proof wool.

It should be emphasized that most genetic engineering research in farm animals has focused on increasing productivity, while research on increasing resistance to disease through genetic engineering (Slater, 1990; Kraemer and Templeton, 1990) is still very much in its infancy. This latter area of research should be questioned since improvements in farm animal husbandry are surely more cost-effective ways of improving animal health and well-being.

TRANSGENIC "MOLECULAR PHARMING"

Human genes are being inserted into farm animals so that they produce various pharmaceutical products in their milk, such as blood clotting factors and other substances of possible medical application (Clark et al., 1987; Watts, 1990; Schanbacher, 1990; Bialy, 1991). Harvey Bialy, editor of *Bio/Technology*, has extolled the virtues of what he terms "molecular pharming technologies," as exemplified by research teams from the UK, U.S. and The Netherlands, who have produced transgenic sheep whose milk contains human alpha-1-antitrypsin, transgenic goats that secrete tPA into their milk and the first transgenic dairy cattle. "Taken together," he writes, "their results provide a convincing demonstration of the feasibility of using animals as commercial bioreactors" (Bialy, 1991). It will be many years before these new animal creations provide any medical benefits to humans, but venture capitalists are investing in this speculative line of research and development. Recently, a biotechnology company, DNX Inc., of Princeton, New Jersey, reported that it has developed a line of transgenic pigs that produce human hemoglobin. But they are still a long way from having hog farmers raise pigs to be human blood donors (Moffat, 1991a).

OTHER INNOVATIONS

Other developments in farm animal biotechnology (which do not entail gene transfer) that can have profound social and economic ramifications include the development of cow clones (Schmickly, 1991) and a technique to preselect the sex of offspring *(Federal Register*, January 10, 1991). Scientists are baffled over the fact that some 25 percent of calves produced by cloning are almost twice the normal size at the time of birth and must therefore be delivered by Caesarian section.

While no plant genes have been inserted into animals, animal genes have been successfully incorporated into the genetic structure of various plants. Tobacco plants have been successfully implanted to produce functional human antibodies, which may be used for diagnosing and treating human diseases. The "antifreeze" gene of the flounder that produces a protein to stop the fish from freezing, has been cloned and inserted into tomatoes and tobacco; crops may be protected from frost in the future by fish genes (Moffat, 1991b).

Since fish farming is on the increase, biotechnologists have been busy developing "superfish," by inserting growth hormone genes from humans, cattle, chickens, mice and other fish into a variety of commercially raised fish,

such as carp, rainbow trout, catfish, Atlantic salmon, walleye and northern pike. The antifreeze gene of the winter flounder is also being inserted into other fish species to expand commercial fish production in cold regions and seasons (*New York Times,* November 27, 1990; Manci, 1989; *Biotechnology and Development Monitor,* 1991; Fischetti, 1991).

A biotechnologist at the Army Research Laboratory in Natick, Massachusetts, has cloned the silk-producing gene of the Golden Orb weaver spider and spliced it into bacteria that in turn produce large quantities of spider silk protein. Stronger than silkworm silk and even steel, this new product may have wide commercial use, especially to develop new fabric for bullet proof vests, helmets, parachute cords and other strong, light equipment (AP news release,.February 27,1990).

On the brave new world frontier of medicine, scientists have created a variety of transgenic mice. Some thirty or more strains of mice have been created that develop various kinds of cancers that affect the mammary glands, pancreas, liver, stomach, bones, brain, eyes and kidneys (Adams and Cory, 1992). Another line of mice have been created that carry human genes that result in deformed red blood cells, providing a new model for sickle-cell anemia (*Genetic Engineering News,* June, 1991), and a line of rats have been developed that carry the defective human gene HLA-B27 that causes a painfully crippling form of arthritis (Fackelmann, 1990). The clinical relevance of these new creations has yet to be demonstrated. Making them transgenic provides no foreseeable benefit to the animals themselves, except perhaps for endangered and genetically "fragile" or defective species, like the cheetah and South American maned wolf.

Research is continuing on the identification of genes responsible for various inherited diseases, especially in purebred dogs and livestock and on genes that play a role in development, growth, milk and egg production, disease resistance and other physiological processes. The results of such costly research may eventually be of benefit to animals in terms of their health and overall well-being. But the benefits will be limited if this approach becomes overly reductionistic and utilitarian and is not integrated with a more holistic, if not traditional, approach to improving animal health and well-being. And especially if it is focused primarily on enhancing the exploitative value of animals.

The human genome is being sequenced and genetic defects and strengths identified. Next will be the cow, the pig and the dog. All to what end? New medical and veterinary products and services will certainly result, including varieties of more productive and disease-resistant livestock. But genetic determinism can lead ultimately to eugenics. And eugenics means genetic imperialism and a new world order for a New Creation. Do we really want or need a Creation made over into a human image of perfect utility?

NEW ANIMAL DRUGS

One potential benefit of biotechnology to animals is in the development of genetically engineered vaccines (including birth-control vaccines), hormones, immune system enhancers and diagnostic and screening tests. However, this new generation of veterinary products and services may be a mixed blessing. It is not without potentially adverse animal health, socioeconomic and ecological consequences-as with BST or bovine growth hormone (Wheale and McNally, 1990; Gendel, 1990). Many of these products are no substitute for humane animal husbandry, sound breeding and good nutrition. There is also some evidence that genetically engineered, modified live virus vaccines may play a role in the development of autoimmune diseases, especially in pure-bred dogs (Dodds, 1990).

PUBLIC ATTITUDES

While private industry and government-funded research centers push forward to create genetically engineered animals that may prove profitable to agribusiness and the medical-industrial complex, the public's attitude toward such developments is noteworthy. In a recent poll across Europe:

> fewer than half thought biotechnological research on farm animals "to make them resistant to disease, or grow faster" should be encouraged. A third thought, applying biotechnology to animals "to develop life-saving drugs or study human diseases" was morally acceptable, "provided the animals' welfare is safeguarded," but 20 percent said it was morally wrong and 27 percent said government should decide each case. Only 13percent thought such work justified"some animal suffering" (Mackenzie, 1991).

A national survey in Japan revealed that 67 percent of people polled were opposed to research that could lead to new forms of plant or animal life (Holden, 1988). Opinion polls in the U.S. show that in 1985, 34 percent of the attentive (informed) public wished to prohibit the creation of new forms of animal and plant life (Feinstein and Miller, 1991). A recent survey in The Netherlands finds that consumers "are very unhappy about eating meat from genetically engineered animals. They are either afraid it will harm them or worried about it on ethical grounds" (Coghan, 1991).

ANIMAL PATENTING

The controversy over the patenting of genetically engineered animals began after the U.S. Patent and Trademark Office ruled on April 7, 1987, that such animals, provided they were nonnaturally occurring "manufactures" and "compositions of matter" could be included under Section 101 of the Patent

Act as patentable subject matter. The patenting of animals was vigorously opposed by The Humane Society of the United States (HSUS) and a coalition of concerned organizations. On August 5, 1987, Representative Charles Rose introduced legislation (HR 3119) to impose a moratorium on the patenting of animals so that the potential adverse implications of such patenting could be carefully studied. And on February 29, 1988, Senator Mark Hatfield introduced moratorium bill S 2111 in the Senate. But on April 13,1988, the U.S. Patent Office and Trademark Office issued Patent Number 4,736,866 on Harvard University's, DuPont Chemical Co. funded, new creation—the "Onco Mouse," a genetically engineered, cancer-prone mouse (Hubbard and Krimsky, 1991).

Since this time, there have been no further animal patents awarded, even though the U.S. government and U.S.-based multinational corporations have been pushing for changes in European patent law that currently prohibits the patenting of animals (Watts, 1991); and even though the State Department effectively squashed the Rose and Hatfield bills on the grounds that they would weaken U.S. economic competitiveness in the world marketplace.

Some 145 patent applications are now awaiting approval at the U.S. Patent and Trademark Office. Approximately 80 percent of these have medical utility while the remainder involve agricultural animals *(Congressional Record-Senate,* June 13, 1991). One explanation for the fact that no new animal patents have been awarded is that there is as yet no clear regulatory structure set up for the commercial marketing of transgenic animals (Charles, 1991; Fox, 1991).

A new bill was introduced in the Senate (S 1291) by Senator Hatfield on June 13,1991, to impose a 5-year moratorium on the granting of patents on invertebrate and vertebrate animals including those that have been genetically engineered. HSUS supported this bill with the following statement published in the *Congressional Record on* that day;

> In order for society to reap the full benefits of advances in genetic engineering biotechnology, the social, economic, environmental and ethical ramifications and consequences of such advances need to be fully assessed. Considering the rapid pace of developments in this field, which will be spurred on by the granting of patents on genetically altered animals, a 5-year moratorium on the granting of such patents is a wise and necessary decision. A moratorium will enable Congress to fully assess, consider and respond to the economic, environmental and ethical issues raised by the patenting of such animals and in the process, establish the United States as the world leader in the safe, appropriate and ethical applications of genetic engineering biotechnology for the benefit of society and for generations to come (pp. 7818-19).

It is very likely that the Council on Competitiveness, chaired by Vice President Dan Quayle, will attempt to block this bill. This same Council has been

actively working to deregulate the entire biotechnology industry. Its proposed administrative and regulatory guidelines for the Environmental Protection Agency and U.S. Department of Agriculture are such that the risks and costs of new biotechnologies—socially, economically, environmentally and in terms of animal-welfare—will be virtually ignored (Charles, 1991; Fox, 1991).

Clearly, while the genetic engineering of animals is not likely to be stopped, increasing public awareness and censure of the biotechnology industry and its political allies is essential. A 5-year moratorium on the patenting of "new" animal creations would be prudent and timely, especially since we are moving into a new world order of free trade, which should be conditional upon effective international regulations and the adoption of the most stringent controls and regulations over biotechnology by all nations. Otherwise, the privatization of the world's resources and of the genetic material of life itself, coupled with the misapplication of genetic engineering biotechnology in agriculture and medicine, will be against the public interest and the good of generations to come.

CONCLUSION

There are several interrelated dimensions to fully evaluating the costs and consequences, risk and benefits of new developments in science, technology and industry, especially in genetic engineering biotechnology; and of the patenting of both processes and products. These dimensions are as follows: ethical and religious, legal and political, social and economic, environmental and cultural. Generally these dimensions of concern, constraint and direction have been virtually ignored by policy-makers and even seen as obstacles to economic growth and industrial expansion. As a consequence, the gap has widened between private (corporate) and public interests. We are witness to a widening of this gap with the rise of a global industrial biotechnocracy, the costs and consequences, risks and benefits of which need to be rigorously evaluated. To voice such concern should not be misjudged as anti-science, anti-progress. Rather, it should be recognized that with greater involvement of an informed public in the policy decision-making process, advances in science and technology and in biotechnology in particular, will be more likely to serve the public good and to help enhance the quality of life and environment alike. Current attempts by the U.S. government to deregulate the biotechnology industry (Phelps, 1991) and by the EEC's Commission on Biotechnology to eliminate socio-economic considerations in the licensing of new animal drugs (Phelps, 1991) support the conclusion that the direction being taken by the biotechnocracy of the industrialized world is neither prudent nor appropriate.

Some proponents of genetic engineering feel "more comfortable" (from a not fully articulated moral/ethical perspective) with the patenting of the *techniques* of biotechnology, rather than with its products, including transgenic

animals. However, the unconditional acceptance of creating transgenic animals for any and all purposes (from the perspective that it is not a moral/ethical issue to create such animals) is as unreasonable as the unrealistic abolitionist position that would prohibit all such research and development (because it is immoral/unethical).

Our power over the genes of life is a recent acquisition, as significant a notch in human evolution as the discovery of pyrotechnology and atomic energy. But this power does not give U.S. the absolute right to transform animals to further satisfy our myriad needs and wants. Rather, it places U.S. on a critical threshold of moral/ethical choice and responsibility. This means that we must choose wisely and compassionately, case by case. We must not forget the history of science, technology and industry. In the past, we have made many wrong choices for selfish reasons, the consequences of which have been as harmful to our own kind as to the rest of Creation, especially to the animal kingdom and to the natural biodiversity of our fragile planetary ecosystem.

ADDENDUM

First Creation-First: Protecting the First Creation from Further Desecration and Transformation

The kinds of plants and animals that are being genetically engineered for agriculture (along with a host of other agribiotechnology products) are primarily those kinds that are being designed for adoption by conventional agriculture. Their adoption and incorporation into our food production system should be contingent upon them quickly helping make industrial agriculture humane and sustainable.

The appropriate use of agribiotechnologies in ecological farming, in holistic resource management and in the development of alternative, socially just agriculture is possible and attainable. It should not be used as another technological fix to compensate for the effects of agricultural degradation, but at the same time aggravate that degradation, necessitating even more costly "fixes." It is surely absurd to use this technology to boost productivity of agricultural commodities that are already in oversupply, like milk.

Genetically engineered bovine growth hormone (BGH)—which is an affront to the science and ethics of good dairy cow husbandry—is the first product that the biotechnology industry has yet to recognize as their own Ford Edsel: And selling it to good dairy farmers is like convincing Eskimos that they need refrigerators.

Increased dependence upon biotechnology will put us on the treadmill of economic competitiveness accelerating the transformation of life into profitable commodities, with the emergence of genetic imperialism and an

increasingly parasitic relationship with the rest of Earth's creation, as exemplified by turning farm animals into bioreactors to produce pharmaceuticals.

Another example of gross misapplication of biotechnology would be to develop a vaccine to make African cattle resistant to Trypanosomiasis rather than using this new technology to increase overall herd health and productivity and indirectly reduce herd size. Such a vaccine would lead to an expansion of livestock into wildlife areas (where wild animals possess natural immunity) and will mean the end of the wild.

While the benefits to animals of making them transgenic are unclear, there are clear benefits of other biotechnologies to enhancing their overall well-being. These include: rapid identification and elimination of genetic diseases; increased disease resistance; protection of endangered species; humane population control of feral and wild species; preservation of genetic diversity; selecting farm animals better adapted to traditional, and alternative, humane husbandry systems; increased efficiency/productivity of farm animals, which will mean fewer animals, more efficient resource utilization and more land being freed up for wildlife habitat recovery.

Appropriate uses of biotechnology in animals should follow the "3R's" of *refinement*, *reduction* and *replacement* in the utilization of animals by society today. We need to not only decrease the suffering and enhance the well-being of animals utilized by society today, we also need to decrease and not increase our dependence upon them for a host of reasons—economical, ethical, environmental, etc. For detailed discussion see Fox, 1992.

Gene mapping and marker-assisted selection to identify useful genes in cattle, hogs and poultry should not be focused primarily on making these animals more productive under conventional husbandry conditions. Overproduction is a chronic and unacceptable problem, lowering farmers' profits and forcing them to get bigger or get out. Better to seek genes that will help livestock and poultry be healthier and better adapted to more ecologically sound farming practices, like rotational grazing of dairy cows and pasture feeding of hogs and helping the livestock population in the Third World cease to expand and to become healthier and more productive. Better still, perhaps, to conserve and propagate rare breeds for such purposes than to create patented transgenic animals derived from narrow utility stock genetically selected for generations to be used under intensive factory systems of production that are gaining widespread societal disapproval.

Above all, new developments in biotechnology should not create *barriers* that would prevent or delay the adoption of alternatives, such as more humane sustainable animal husbandry practices and greater advances in public health, education and nutrition instead of creating ever more transgenic mice. With these considerations and caveats, the appropriate application of biotechnology in animals will be more reasonably assured and objectively determined.

The biotechnology explosion has resulted, over the past decade, in the creation of over 10,000 new lines of transgenic mice; in farm animals with human genes producing milk with new health promises to offer genetically impaired and immune-compromised people; in genetically engineered plants secreting spider venom. Human disease antigen injected into cows to provide day care infants and others with protection from the diseases that are spread and potentiated by their situation may soon be marketed. Milk contains a natural opiate, which may help calm some kids down. Selecting cows to produce opiate-rich "Sleepy Time" milk may be on the horizon soon. Already there is a company developing a transgenic pig industry to provide "xenografts"—genetically humanized swine hearts, livers and kidneys—for humans in need of such organ transplants.

These new directions and applications of biotechnology make one wonder when there will be a concerted effort to develop and distribute a safe and effective, if not also a reversible, genetically engineered contraceptive. That it will be developed and marketed for women first should not be an obstacle to its widespread adoption. The Catholic Church could help by embracing the view that such an application of biotechnology is to use our God-given power over the gene for reasons of compassion and to further the greater good and future security of all Creation.

We must stop multiplying our numbers, needs and wants. And we must learn to live gently and simply so that others may simply live. We need to stop regarding technological progress as unstoppable. It is *change* that we cannot stop; and it is up to us to direct progress, to take charge of the direction new technologies might take in order to maximize their benefits and minimize their costs and risks to all concerned. We need to constantly redefine what true progress is in order to implement correctives and preventatives where needed.

The mutant "monster" creation of genetic engineering we all feared has already been created and released into the world. It is not some insulation-eating superbug, AIDS-like virus, mind-altering transgenic pollen, or Iowa corn plant that eats Texas beef. This monster seeks to use biotechnology for purely materialistic and consumptive ends and is preparing to remake creation into its own image of how the natural world can best serve its myriad consumptive needs.

The primary purpose behind the genetic engineering of Second Creation products is their profitability to their makers: the remakers of the First Creation. The mythic image of this mutant monster that connects us to a fate far more terrible than that of a Midas, Icarus, Prometheus or Marsyas, is so because it consumes itself as it destroys the Earth's natural resources.

After the carnage, the pestilence, the long drought, the ozone hole, Chernobyl, pesticide rain and shores reeking with dead seals and dolphins, what will there be? What is coming is what we see, unfolding before our very eyes.

Genetic engineering and all applicable technologies should first and foremost be directed at these kinds of issues and with the vision and ethics of

organic, if not sacred, unity rather than at developing new biotechnology products to help boost a non-sustainable agricultural system and an unethical biomedical research industry. The so-called health industry fights cancer with tons of profitable treatment, but not an ounce of prevention and justifies untold animal suffering in the name of medical progress.

How can we have a government with health and agricultural agencies that are not in concert, but in kahoots? For them to prohibit the wholesale application of thousands of potential carcinogenic chemical pesticides and the millions of tons of petrochemical fertilizers by the feed and food industry would be in the public interest. So why has this not been done and countless other social and ethical issues addressed by industrial world governments? Perhaps not until we all confront our own personal monsters and demons and discover that we are all related.

We cannot continue to be blind to the irony that there are many publicly supported corporations that are distributing pesticides, as well as processing and marketing various crops and factory-farmed animals; developing and patenting genetically engineered mice and selling x-ray film for nationwide, annual mammograms.

The monster on this planet is a product of biotechnology because in breaking the DNA code, it became addicted to changing the codes of life to serve its own industriously Earth-transforming and all-consuming existence.

The male of this monstrous product of biotechnological skill and arrogance likes those of its opposite sex to have large firm breasts. It even sells them breast implants when their natural breasts become cancerous with the poisons of industrial indifference, ignorance and greed.

The entire immune system within the monster body-human, the *corpus* of industrial civilization, is beginning to break down. It is creating thousands of varieties of transgenic mice to find ways to help its failing immune system adapt to an increasingly dysfunctional and hazardous society and environment. The monster's name is Nemesis. His mate, more ignorant than Eve and not so loving and alive, is a modern Pandora with perfect silicone breasts.

Where nature is the least defiled, humans still go to rest, dream, heal, play and pray. But some still come to these sacred places—the dying remnants of the First Creation—simply to take. They must be stopped by all and every means for our children's sake and for all other creatures great and small.

To conclude, from an ethical and spiritual perspective, the future of the natural world or First Creation will only be secure if this new technology is applied like no other before it. Otherwise, the Second Creation will mean a wholly unnatural, humanized world as we transform the First Creation into a bioindustrial system remade into our own self-serving materialistic image of utility and productive efficiency.

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